

The pet mantis market: a first overview on the praying mantis international trade (Insecta, Mantodea)

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Abstract

Praying mantises have recently gained popularity as domestic pets. Moreover, they are increasingly being bred and sold in fairs and pet markets or collected in the wild and reared by amateurs or professional marketers for the hobbyist community. This market is not well known, and its implications on the biology and conservation of these insects are complex and difficult to predict. For this study, a comprehensive survey was submitted to various hobbyists within this community to evaluate their knowledge of these insects and to assess their preferences for certain species characteristics (such as shape, color, behaviors, dimensions, ease of breeding, and rarity) over others. The aggregation of this data allowed for the generation of a formula that is herein proposed to predict targets and developments within the market in order to help identify conservation issues for vulnerable species. Both problems and opportunities of the pet mantis market are discussed, such as the absence of specific regulations or the potential for a stronger collaboration between the market community and scientists.

Keywords

animal selling, biodiversity, breeding, conservation, hobby, insects, laws

Introduction

Over the last decade, interest in insects as domestic pets has shown a remarkable increase. From the first butterfly farms launched in the mid-nineteenth century that produced exhibits for museums and public insectariums, the market of these unconventional pets has shifted towards pet shops and domestic rearing. This novel market has yet to be investigated from a scientific perspective, and the few statistical data available are mostly outdated, even though this market is quite financially lucrative. Within the butterfly trade alone, top suppliers generate about 100 million dollars each year worldwide (Parson 1992). In more recent years, pet shops, insect fairs, and markets have introduced other exotic insects and other invertebrates, such as

beetles, stick insects, mantises, spiders, scorpions, and snails. These market introductions are typically small in number but may experience unexpected booms. For example, when the price for a single adult stag beetle reached approximately \$5,000 in Japan, the country introduced a law to allow more species to be imported each year, with an average total annual increase of about 375% from 1999 to 2003 (Goka et al. 2004).

Before the actual size of this trading industry was determined, the first evidence of an existing black market appeared in press media (e.g., FOX19 (2020), The Sun US (2020), WDRB Media (2020)), suggesting that its value was already significant and increasing. Although data exists concerning the trade of some butterflies and a few beetles (15 genera of Lepidoptera and 2 of Coleoptera are listed in the CITES appendices and discussed in international laws), almost nothing is known about orthopteroid insects such as stick insects and mantises. In particular, after their first appearance in some thematic insect fairs (see Fig. 1) some decades ago, mantises now have a constant presence in many general pet animal fairs/markets in Europe, USA, and Japan—the three world regions known to be principal importers of exotic insect pets. Rearing mantises at home is not easy and requires at least some basic knowledge on the biology of these insects—sometimes even of the particular species—which is something that has yet to be detailed by scientific literature. Despite these problems, the number of social media posts and the proliferation of specific pages on mantis rearing and breeding suggests that the interest in keeping mantises as pets has increased dramatically in recent years.

The conservation of mantises is also an almost unexplored field (Battiston 2014, Battiston et al. 2014), as this group of insects suffers from data deficiency in taxonomy, population trends, threats, and the impact of commerce that hinders their inclusion on red lists and in legislation. For example, law and policy regulations are explicitly invoked, even if on different/unknown scales, as conservation action is needed for three data deficient mantis species in the IUCN Red List of Threatened



Fig. 1. Mantises sold in an exotic animal market fair in Italy. Photo credit R. Battiston.

Species (*Perlamantis alliberti* Guérin-Meneville, 1843, in Battiston 2020; *Empusa pennicornis* Pallas, 1773 in Shcherbakov and Battiston 2020a; and *Iris polystictica* Fischer-Waldheim, 1846 in Shcherbakov and Battiston 2020b). In the recently compiled IUCN red list assessments of the Mantodea of Europe, 12 of the 37 species listed and assessed at a global level are classified as of least concern, 9 as threatened or extinct, and 16 as data deficient (IUCN Red List of Threatened Species – Mantodea). Europe is neither the richest region for mantis diversity nor the most representative for these insects, but it is probably the most entomologically well-known and studied area. Even with this long tradition of scientific research, the knowledge and conservation of these insects is still poor.

Almost no data exist on collecting activities and quantities in the wild and how collecting may impact a species that is abundant in its habitat. The voluntary or accidental release of a reared exotic species into foreign ecosystems is also a problem. *Mantis religiosa* Linnaeus, 1758 and *Tenodera sinensis* Saussure, 1871 were accidentally introduced in the late nineteenth century into the USA. These species were then bred as a biological control agent and spread in large numbers over most of the country, where they now have a stable population, but their impact is still not well understood (Anderson 2018). More significant is the case of *Miomantis* Saussure, 1870, an African mantis frequently bred commercially and privately, that was recently found in the wild with vital populations in Portugal (Marabuto 2014), USA (Anderson 2018), and New Zealand,

where it is impacting the local species (Fea et al. 2013). In the last few years, the mantis fauna of Europe have greatly increased; this increase has been hypothesized to be due to the diffusion of exotic species in nature and the resultant competition with native species (Battiston et al. 2018, 2020, Schwarz and Ehrmann 2018, Shcherbakov and Govorov 2020). Their origin, whether from escaped/released pet breedings or from oothecae attached to trading goods, is still under debate, but each species probably has its own history.

Because of the lack of direct data on this market, especially from the supply side, we collected indirect information from consumers through a survey designed to analyze the desires of buyers of insects as domestic pets. These data were then used to estimate the direction of this market by pointing out the possible targeted genera or species from a conservation perspective.

Materials and methods

During 2018, an online anonymous survey was used to collect information from mantis enthusiasts. The survey was translated into different languages (English, Italian, Spanish, and Russian) and spread around the internet primarily through social media and web communities known to deal with general entomology or those specific to mantises. The survey consisted of 24 questions on four main areas of investigation: 1) generalities on the compiler and motivation to buy and rear mantises, 2) relationship between the compiler and the market, 3) knowledge of the compiler on the

Table 1. Principal descriptive characters used to identify the commercial value of a species divided by the main categories (shape, colors, behaviors, dimensions, ease of breeding, and rarity on the market) and the value points (from 1 to 5) given to each.

Value Points	Shape	Color	Behavior	Dimensions (Adult)	Ease Of Breeding	Rarity
1	Generalist	Homogeneous	No particular behaviors	Very small (<3 cm)	Low resistance of the species outside their natural habitat	Available in almost any insect fair/market
2	Slightly lobed	Heterogeneous	Specialized cryptic posture	Small (3–5 cm)	Terrarium that accurately replicates the specie's natural habitat	Uncommon species in fairs/shops
3	Evident expansions	Some particular aposematic/ cryptic colors	Particular aposematic or deimatic posture	Medium (5–7 cm)	Daily control over the main habitat parameters (temp., hum., food)	Rare species, available mostly through direct contact
4	Peculiar	Evident aposematic and/or cryptic colors	Unique static postures	Large (7–9 cm)	Species moderately adaptable to different habitat parameters	Species held only by very few breeders
5	Unique and spectacular	Unique camouflage and/ or aposematic coloration	Complex rituals (mating, hunting, etc.)	Huge (>9 cm)	Species very adaptable and anthropophilic	Species not yet introduced in the market

international animal trade market and its regulations, and 4) perception of the problems and opportunities that arise from buying and rearing mantises.

Based on the answers to the preferred characters considered in the choice of a certain species of mantis (Table 1), a predictive formula is proposed here to estimate the general value of a single species on the market to *a priori* predict how the market may evolve and determine which species may be the targets of trade in the near future.

Each of the identified characters—shape (S), colors (C), behaviors (B), dimensions (D), ease of breeding (E), and rarity on the market (R)—was rated in the survey from 1 (less important) to 5 (most important). Subsequently, each of these characters was weighted considering their relative importance as reported in the survey. These weights (respectively: a, b, c, d, e, f) were calculated from the sum of the relative number of votes obtained in the survey for each character over the total and given in percentages.

The economic value (V) of each mantis species was calculated using the sum of all the characters values proposed as variables (respectively S, C, B, D, E, R) multiplied for their relative weight coefficients obtained from the preferences given in the survey, and two additional coefficients (X, Y) were included to level out the output value according to present market prices as the best fitting model. This last calibration on the current market prices was done using a second survey presented to 10 known sellers from different European countries who specialize in mantises, asking them to give a price for a sub-adult or adult individual from a list of the best-selling mantis species in the present market.

The final formula to calculate and forecast the economic value (V) of a mantis species is as follows:

$$V = \frac{Sa + Cb + Bc + Dd + Ee + Rf}{X} + Y$$

For this study, the mantis market was monitored and studied from 2018 to 2022 using social media and websites. To evaluate the interest in mantises as pets, the Google Trends tool was used to compare the appearance of the general keyword 'mantis' in the Google search engine from January 2004 to January 2022 and all over the world in all categories versus the category "pets and animals". Since the word 'mantis' also refers to well-known comic superheroes, video game characters, or non-insect animals, the following keywords were excluded for in the search: marvel, comics, shrimp, guardians, and game.

Results

A total of 181 surveys from 28 countries were compiled and processed. The participants in this survey ranged in age from 19 to 30 years (53%), and most bought mantises for personal curiosity (39%) or scientific/professional interest (29%). Beautiful looking species (52%) were preferred over rare ones (11%), and the ease of rearing the species was essentially irrelevant (9%). To obtain a beautiful species, the typical breeder/enthusiast expressed being willing to spend over \$30 (27%), while a general price ranging between \$20 and \$30 was considered good for a single mantis individual (46%). For the privilege of rearing exclusive/rare species, spending an amount over the average was considered reasonable by approximately one in every four participants (26%). The preferred choice of insect stage was mostly young nymphs (44%) or oothecae (14%), which are usually less expensive than adults (9%). A low price is sometimes more important than the stage (14%), but many buyers also consider the shipping circumstances, such as the distance and time needed for transport (19%).

More than 80 genera of mantis are currently sold and reared, but 6 are most common and preferred—*Hierodula* Burmeister, 1838 (23%), *Phyllocrania* Burmeister, 1838 (21%), *Creobroter* Westwood, 1889 (14%), *Sphodromantis* Stål, 1871 (12%), *Mantis* Linnaeus, 1758 (12%), and *Hymenopus* Serville, 1831 (11%)—over others (7%).

The relationship of the buyer with the seller is usually transparent (73%), and trade seems to take place mostly on the white market, but approximately one in every four transactions leave the buyer perceiving a lack of transparency from the seller or are done without the appropriate permits. In shipping, the contents of a package carrying a living mantis is often explicit, especially where required (29%), but the insect is usually not declared, mostly in an attempt to bypass customs bureaucracy or avoid problems caused by delayed delivery of delicate, live insects.

The participants frequently reported that a mantis in their possession did not come from the market; rather, it was directly collected in the wild (59%) and, in this case, it was usually reared until natural death (31%) or released near the place of capture (25%). The insect was released several kilometers away from the collecting place in only a few cases. Collecting in the wild was rarely declared by the seller, but it was privately communicated or understood by the buyer in 26% of transactions.

The participants' average knowledge on mantis-trade legislation was mostly low or fragmented, especially at the international level: 77 to 90% of the answers on this subject (ranging from CITES annexes to the Nagoya protocol) were identified as not known or incorrect.

The formula proposed to calculate the current mantis value (V) of a species considering the variable characters obtained from the survey is as follows:

$$V = \frac{2.5S + 1.9C + 1.8B + 1.4D + 1.1E + 1.3R}{20} + 2.7$$

When V values were compared with the respective average prices declared by the sellers (Fig. 2), the average error obtained between these two values for each species was 16%. It should be noted that the declared prices varied from one seller to another, with an average difference (max-min) of 30%; price also varied depending on insect stage, with young neanids being cheaper than adults or

subadults. Rarity was also a variable character because it changes over time and evolves with the market; however, rarity is a variable that can be changed according to current market conditions.

We found that the trend of the keyword mantis has decreased in the last 18 years (2004–2022), while its presence in the category 'pets and animals' has increased (Fig. 3).

Discussion

The impact of the mantis trade market both on the general animal trade economy and upon conservation of these insects is still far from being fully understood. The general output obtained from our analysis, however, fits well with a young and still rapidly evolving market. The dynamics and average prices spent for these pets are now comparable to that of many fishes, reptiles, birds, or mammals, considering also that the lifetime of mantises is much

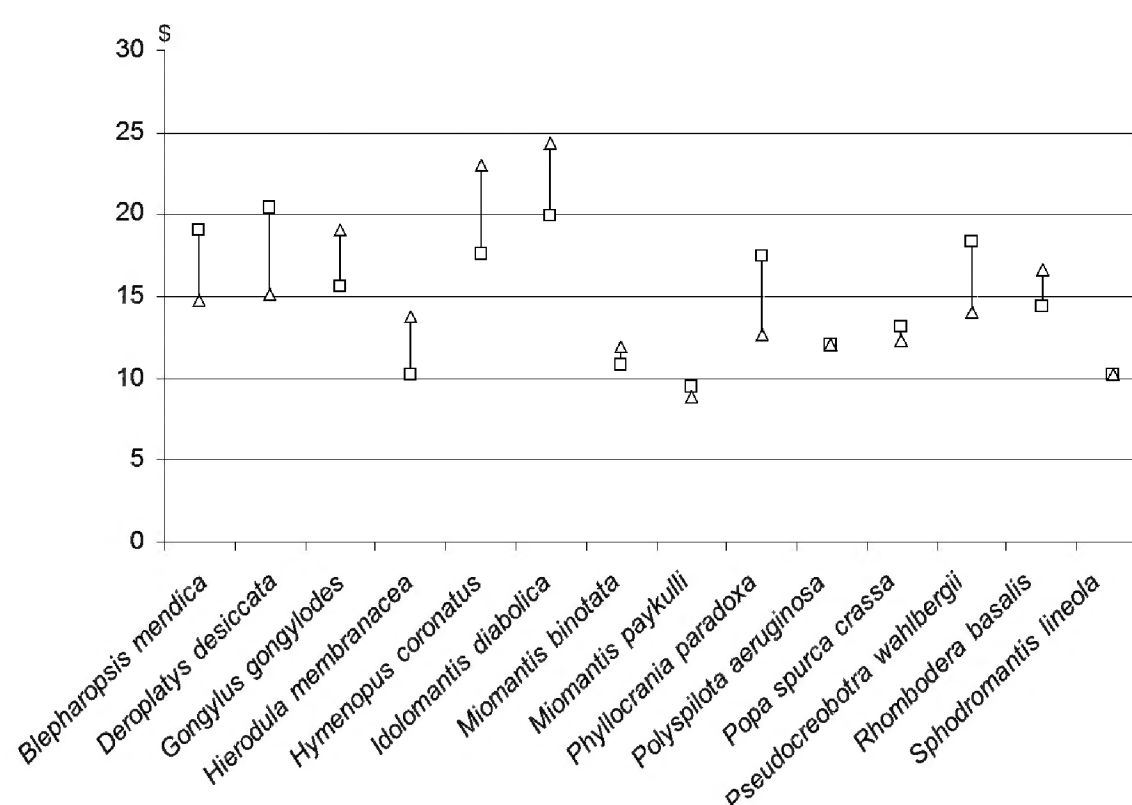


Fig. 2. Average prices (in US dollars, y axis) of the most commonly traded species (x axis) declared by the sellers (triangles) and calculated as the mantis value V (squares).

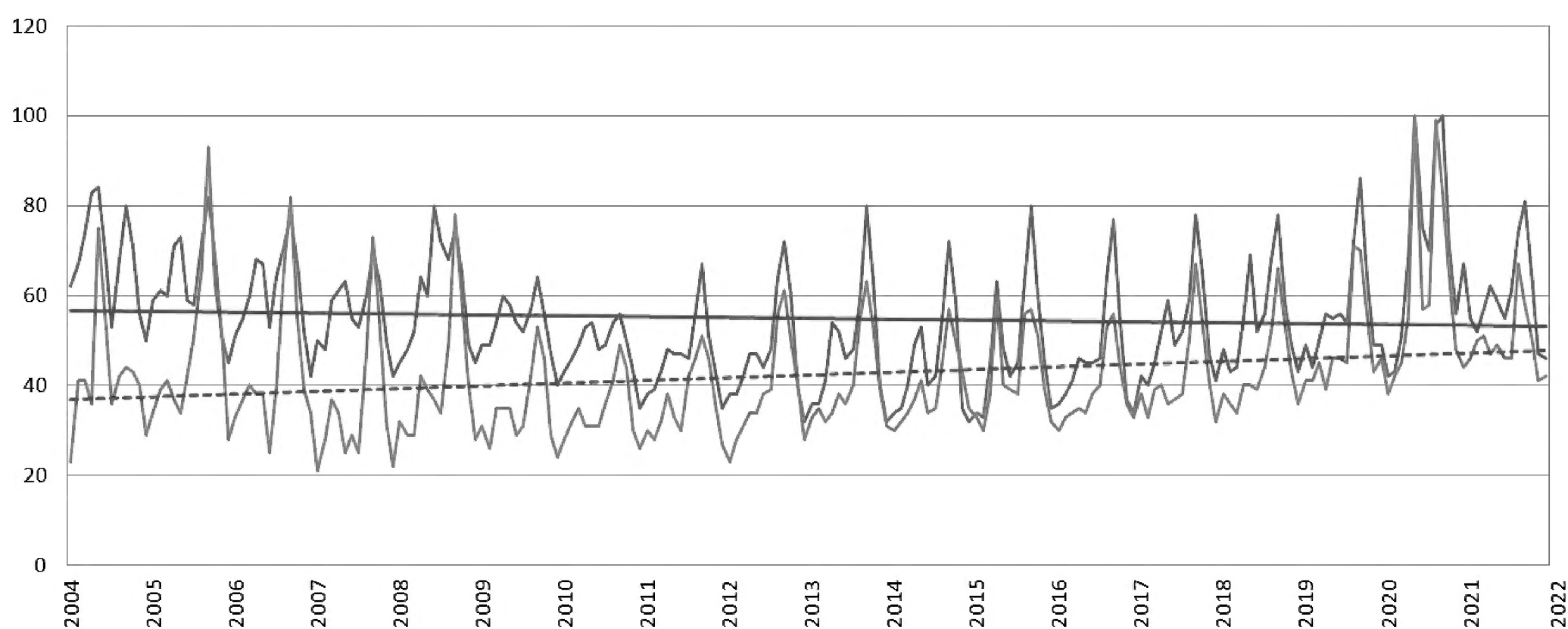


Fig. 3. Google trends of the keyword 'mantis' from 2004 to 2022 (x axis). The appearance (y axis, in a default scale from 0 to 100) of the general term (blue line, continuous green trend-line) is compared to its presence in the category 'pets and animals' (red line, dashed green trend-line).

shorter, on average, than that of vertebrate pets. While this market is probably still a small niche of the global animal trade market, the money that it generates is currently unquantifiable and may hold some surprises.

Buyers are mostly curious enthusiasts with a poor knowledge of the market dynamics and the laws behind it, although they seem to generally care about their pets, collecting information on them and their needs when available. Collecting specimens from the wild instead of rearing them from first instars may be an easier option for many occasional breeders, especially if the breeder resides in a tropical country that host the highest diversity of species as well as the most preferred ones.

The release of exotic species into non-native habitats appears to be limited, and, at this time, the arrival of alien species is more likely to be caused by cargo or accidental transport of oothecae (Battiston et al. 2018, 2020, Shcherbakov and Govorov 2020). However, voluntary pet release should be considered in future studies on the prevention of such spreading, especially related to more generalist and well-adapting species.

It should be noted that spikes in the interest in mantises is rather predictable; most of the internet searches (Fig. 3, positive peaks) identified in this study occurred in September, a month when, in temperate regions, many mantis species reach the adult stage and are more active and visible in nature.

The impact of this market on mantises and their environment remains unquantifiable, but there is evidence that a good number of individuals insects or oothecae are collected in the wild, and this may have a significant impact on the local populations of some species. The high number of oothecae, often collected in nature and in single localities, that are sold through social media sites are a clear sign of this threat, especially when related to uncommon native species (e.g., *Idolomantis diabolica* (Saussure, 1869), one of the rarest, most desirable and highly priced species on the market; Fig. 4). Even more common species already under the pressure of alien competitors, as is the case for *Stagmomantis carolina* (Johansson, 1763) in the United States (Maxwell and Eitan 1998, Anderson 2018), may suffer from intensive field collecting. Also, unpredictable effects may emerge from the commerce of non-native species. Removing oothecae of the

Asian *Tenodera angustipennis* Saussure, 1869 from a North American field may be good for the local ecosystem, but these oothecae can spread to other localities, increasing the potential threat on other vulnerable ecosystems; moreover, they are not easily distinguished from the oothecae of *Stagmomantis carolina* (Fig. 4), whose removal can be counterproductive, as explained above.

For future interventions, assigning a price that takes the insect's habitat into consideration may promote the value of nature and biodiversity in specific areas. If the value of a species is predictable, according to the development of the market, specific measures can be taken to protect individual species.

At the present time, the market for insects as domestic pets is almost completely unregulated, and its future is difficult to forecast. On one hand, awareness toward a free market and of the biological needs, threats, and impacts on the species being sold should be promoted. Good conservation legislation should support this development, not general and uncritical replications of the legislation designed for vertebrates, on invertebrates, something that has already started to seriously hinder scientific research (Prathapan et al. 2018, Britz et al. 2020, Williams et al. 2020). Future regulations must allow adjustments for specific species and situations, in accordance with the scientific community.

On the other hand, this market is nearly the only source of information on insects whose biology and ecology are still poorly known and that are difficult to study. This point is reinforced by the status of previously assessed mantis species in the IUCN Red List of Threatened Species, where most mantis species are listed as Data Deficient. Of course, knowledge alone is not enough to save these species from extinction, but it is a valuable foundation. The lack of data on mantises hampers implementation of effective conservation measures (Hochkirch et al. 2021). The community around the mantis pet market is already large and active (Durrant 2003, Maxwell 2011), giving it the potential to be a strong ally in efforts to fill this gap. For this reason, efforts should be made to encourage this community to stay active and work with the scientific community. The value of such collaboration is exemplified by the countless number of scientific papers published using citizen-science data (e.g., Battiston et al. 2021, Moulin 2020) or observations on the biology of wild or



Fig. 4. Stocks of oothecae sold through social media (Facebook groups related to mantis enthusiasts). *Idolomantis diabolica* (Saussure, 1869) from Tanzania (left) and *Stagmomantis carolina* (sold as *Tenodera*) from the United States (right).

reared specimens (e.g., Battiston and Carolo 2018). Improving this relationship will help to identify target species and promote their study, which are important steps toward obtaining more information on their conservation status.

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